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March 5, 2002

BOX PCT

Commissioner for Patents
Washington, D.C. 20231

PCT/AUOO/01023
-filed August 30, 2000

Re: Application of Michael COX et al, Micky VUCIC, Bui BANH
RECURSIVE TRAFFIC DISTRIBUTION IP/DATA NETWORK MODEL
Assignee: ALCATEL
Our Ref: Q68557

Dear Sir:

The following documents and fees are submitted herewith in connection with the above application for the purpose of entering the National stage under 35 U.S.C. § 371 and in accordance with Chapter II of the Patent Cooperation Treaty:

- ☐ an executed Declaration and Power of Attorney.
- ☒ an English translation of the International Application.
- ☒ 3 sheet(s) of drawings.
- ☐ an English translation of Article 19 claim amendments.
- ☐ an English translation of Article 34 amendments (annexes to the IPER).
- ☐ an executed Assignment and PTO 1595 form.
- ☒ a Form PTO-1449 listing the ISR references, and a complete copy of each reference.
- ☒ a Preliminary Amendment

The Declaration and Power of Attorney, Assignment, will be submitted at a later date.

It is assumed that copies of the International Application, the International Search Report, the International Preliminary Examination Report, and any Articles 19 and 34 amendments as required by § 371(c) will be supplied directly by the International Bureau, but if further copies are needed, the undersigned can easily provide them upon request.

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**PLEASE SEE THE ATTACHED PRELIMINARY AMENDMENT BEFORE
CALCULATING THE FEE**

The Government filing fee is calculated as follows:

Total claims	<u>7</u> - 20 = _____	x \$18.00 =	<u>\$0.00</u>
Independent claims	<u>2</u> - 3 = _____	x \$84.00 =	<u>\$0.00</u>
Base Fee			<u>\$890.00</u>

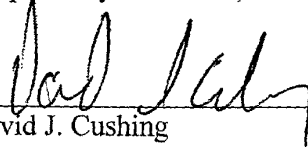
TOTAL FEE			<u>\$890.00</u>
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A check for the statutory filing fee of \$890.00 is attached. You are also directed and authorized to charge or credit any difference or overpayment to Deposit Account No. 19-4880. The Commissioner is hereby authorized to charge any fees under 37 C.F.R. §§ 1.16, 1.17 and 1.492 which may be required during the entire pendency of the application to Deposit Account No. 19-4880. A duplicate copy of this transmittal letter is attached.

Priority is claimed from:

<u>Country</u>	<u>Application No</u>	<u>Filing Date</u>
Australia	47400/99	September 6, 1999

Respectfully submitted,


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Date: March 5, 2002

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of PCT/AUOO/01023
Michael COX et al, et al. Attorney Docket Q68557
Appln. No.: Not Assigned
Confirmation No.: Not Assigned Group Art Unit: Not Assigned
Filed: March 05, 2002 Examiner: Not assigned
For: RECURSIVE TRAFFIC DISTRIBUTION IP/DATA NETWORK MODEL

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination, please amend the above-identified application as follows:

IN THE SPECIFICATION:

Amend the specification by inserting before the first line the sentence:

On Page 1, please amend the fourth full paragraph beginning with "In our co-pending application" as follows:

In our co-pending application number 44470/99 (127045 SY) (corresponding to U.S. Patent Application No. 09/371,503), we disclose a network in which the message is spread over all the practical paths between the source and destination. An advantageous embodiment of that invention involves the elimination of paths having heavily loaded links. Again, the implementation of this technique requires the exchange of load status information between nodes, generating a large volume of traffic.

IN THE CLAIMS:

Please cancel claims 8 and 9 in their entirety and without prejudice or disclaimer.

The claims are amended as follows:


3. (Amended)An arrangement as claimed in claim 1 wherein, in the first level, a selected node in each group is designated as the master node for the corresponding group,
 - the master node managing the transfer of node load status information within its corresponding group.
4. (Amended)An arrangement as claimed in claim 1 wherein the load status information includes information on the available traffic capacity between the ports of each unit.
5. (Amended)An arrangement as claimed in claim 1 wherein each node includes node load status monitoring means to monitor the load status of the links connected to the node.
6. (Amended)An arrangement as claimed in claim 1 wherein at least one node of each second level group is connected to a node of at least one other second level group via a corresponding group link whereby group load status information can be interchange.

Preliminary Amendment
Attorney Docket Q68557

REMARKS

Entry and consideration of this Amendment is respectfully requested.

Respectfully submitted,


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Date: March 5, 2002

APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

The specification is changed as follows:

On Page 1, please amend the fourth full paragraph beginning with “In our co-pending application” as follows:

In our co-pending application number 44470/99 (127045 SY) (corresponding to U.S. Patent Application No. 09/371,503), we disclose a network in which the message is spread over all the practical paths between the source and destination. An advantageous embodiment of that invention involves the elimination of paths having heavily loaded links. Again, the implementation of this technique requires the exchange of load status information between nodes, generating a large volume of traffic.

IN THE CLAIMS:

Please cancel claims 8 and 9 in their entirety and without prejudice or disclaimer.

The claims are amended as follows:

3. (Amended) An arrangement as claimed in claim 1 ~~or claim 2~~ wherein, in the first level, a selected node in each group is designated as the master node for the corresponding group,
 - the master node managing the transfer of node load status information within its corresponding group.

4. (Amended) An arrangement as claimed in claim 1 ~~or claim 2, or claim 3~~ wherein the load status information includes information on the available traffic capacity between the ports of each unit.

5. (Amended) An arrangement as claimed in ~~any one of claims 1 to 4~~ claim 1 wherein each node includes node load status monitoring means to monitor the load status of the links connected to the node.

6. (Amended) An arrangement as claimed in ~~any one of claims 1 to 5~~ claim 1 wherein at least one node of each second level group is connected to a node of at least one other second level group via a corresponding group link whereby group load status information can be interchange.

RECURSIVE TRAFFIC DISTRIBUTION IP/DATA NETWORK MODELTechnical field

This invention relates to a method and arrangement for transferring network node status information between nodes.

5 Background Art

Least cost routing examines the network topography to determine the shortest path between the source of a message and its destination. This method does not take account of the load status of the individual links of the chosen path so one or more of the links may become overloaded, preventing or disrupting the delivery of the message to the destination.

10 An alternative proposal is to take into account the load status of the links when determining the chosen path. Thus the system may determine all the shortest paths and make the path selection on the basis of the path with the links carrying the least traffic. To implement this, it is necessary for all the nodes to exchange load status information. As the number of nodes and links in a network grow, the implementation of this technique requires the exchange of a large amount of load status traffic, as each node broadcasts the load status of its associated links to the other nodes.

15 In our co-pending application number 44470/99 (127045 SY), we disclose a network in which the message is spread over all the practical paths between the source and destination. An advantageous embodiment of that invention involves the elimination of paths having heavily loaded links. Again, the implementation of this technique requires the exchange of load status information between nodes, generating a large volume of traffic.

25 Disclosure of the Invention

This specification discloses a network arrangement for a plurality of nodes each node being connected to one or more other nodes by corresponding node links,

- the network being arranged into a recursive hierarchy of units having
30 two or more levels,
- the nodes being the units of the first level of the hierarchy,

- the units of higher levels of the hierarchy being formed by groupings of the units of the previous level,
- wherein the units of a level exchange a corresponding load status information.

5 This invention can be used in conjunction with the maximal flow techniques described in 44470/99 to determine suitable paths with available capacity.

Brief Description of the Drawings

10 Figure 1 is a schematic representation of a network in which the nodes are arranged in a recursive hierarchy, in accordance with an embodiment of the invention.

Figure 2 represents a load status monitor.

Figure 3 illustrates the message structure for exchanging information at different levels.

Best Mode of Carrying out the Invention

15 Figure 1 shows a network of nodes interconnected by links. According to the embodiment shown in Figure 1, the nodes are linked in a logical hierarchy.

The nodes exemplified by the circles, some of which are numbered 101 ... 202 ... 303 ..., are shown interconnected by node links, represented by the lines drawn between the nodes.

20 The nodes are formed into groups 10, 11, 12, 20, 30. The groups are interconnected by group links, for example 1001 between node 105 of group 10 and node 121 of group 12.

The group links are shown in the following Table 1.

TABLE 1 : GROUP LINKS

Node/Group		Node/Group		Link
105	10	121	12	1001
112	11	122	12	1002
103	10	111	11	1003
123	12	202	20	1201
101	10	302	30	1301
102	10	303	30	1302

Preferably the group links have a larger traffic capacity than node links. Group links may equate to regional trunks within a particular carrier's network, or to links between different carriers, different countries or different global regions, for example.

5 As shown in Figure 1, the levels of the hierarchy start with the nodes. The units of the second level are the groups of nodes. The units L31, L32, L33, of the third level are one or more groups, and the units of the fourth level, L41, L42 are formed by aggregating units of the third level. Thus L41 is the aggregation of L31 and L33, while L42 encompasses L32.

10 Preferably the nodes are grouped on the basis of communication path topography so that there are relatively few links in the shortest path between any two nodes in a group.

The groups themselves, 10, 11, 12, 20, 30 are linked by designated links 1001, 1002, 1003 1201, 1301, 1302 connecting designated nodes in the
15 corresponding groups.

Within each group, a master node is assigned, 104, 113, 124, 201, 301. Because each node in a group knows the load status of all the links in that group, the master node has the information to enable it to compile available capacity reports adapted to meet the requirements of the higher levels.

20 The physical node interconnections are illustrated at A in Figure 1 and B,C and D illustrate the conceptual logical links for the second, third and fourth levels of hierarchy.

At level A, the nodes of each group communicate load status information to each of the other nodes of the corresponding group.

25 Thus the master nodes 104, 113, 124, of the network 1 shown at B are aggregated under the supervision of a single master node 113 which is assigned to the next higher level. Because, in the example shown, networks 2 and 3 have only one group, the same master 201, 301 is used all levels.

At level C, the master nodes 113, 201, 301 exchange information as to the
30 overall load status of their associated networks 1, 2, and 3.

The nodes at level C are then 113, 201, 301. By then aggregating 113 and 301, one of these two can be designated to manage the level D information exchange for both network 1 and network 2. Thus at level D, 201 and 301 can exchange information on the available capacity for the regions covered by L42 and L41.

At level C, information on the capacity of networks 1, 2 and 3 is exchanged between the networks. At level B, information on the capacity of groups 10, 11, 12, 20, 30 is exchanged between the groups.

At level A, the nodes interchange information on traffic capacity at the node link level, within the groups.

Figure 2 shows an arrangement for monitoring the available capacity of the links connected to a node.

For each link connected to a node there is a buffer 51, 52, 53, e.g. in the form of FIFO.

The traffic level monitor 50 checks the level of the contents of the buffers to measure the available capacity on the basis of the speed of the link associated with the buffer. The result of the monitoring is then reported to the other nodes in the same group.

In a simplified measuring system the monitor may report whether or not a link has spare capacity, e.g. by checking whether a buffer's content is above or below a predetermined threshold.

The load status information exchange is carried out on the following basis.

The nodes within a group each notify the other nodes within that group of the load status of the links connected to the notifying node.

At the group level, each group notifies the other groups of the load status of the links connected to the notifying group and a summary of the load status of internal paths within the group available for interconnecting the group links connected to the notifying group.

For example, Group 12 is connected to Group 20 via link 1201, to Group 10 via link 1001, and to Group 11 via link 1002.

Preferably, the designated as a master node manages the interchange of information between the groups.

Table 2 shows the master nodes for each group.

TABLE 2

5

GROUP	MASTER NODE
10	104
11	113
12	124
20	201
30	301

As can be seen in Figure 1, the master nodes take part in the higher level exchanges but their number is progressively reduced by the recursive grouping.

Thus, in the embodiment shown in Figure 1, while there are 5 master nodes shown at level B, there are only 3 at level C and 2 at level D.

Preferably, the grouping is carried out on the basis of proximity in the sense of the number of links in the path. Of course this is not a strict rule at the node level because the nodes at either end of a group link are joined by a single link, while there may be more than 2 links between nodes within a group. Other factors which influence grouping are geographical proximity and network ownership, as well as the traffic flows.

For example, the nodes of network 2 may be geographically close to node of network 1, but network 1 may be owned by a different carrier from network 2.

At level D, the nodes 201 and 301 exchange information on the available capacity between network 3 and network 2 and the transit capacity of the respective networks. This information would, for example, be based on the load status of links 1201, 1301, 1302, and the capacity across network 1 between link 1201 and the links 1301, 1302. The information need only identify the maximum available capacity at the time, which varies in accordance with the load on the various network elements.

For the sake of clarity the information will be given the following names:

Level D = Regional;

Level C = Network;

Level B = Group;

5 Level A = Node.

Regional information may be, for example, the maximum available capacity between the "electrically" remotest groups. The term "electrically" refers to the number of links and may include cable, optical and radio links.

10 Network information may be, for example, the capacity between the various networks, including the trans-network capacity between the network links 1201, 1301, 1302.

Group information could be typified by the capacity between groups, including the trans-group capacity between the group links.

15 Node information is the information broadcast by a node to the other nodes within its group as the load status of the node and its associated links.

Group information can be deduced from node information. Each node in a group knows the load status of all the nodes in that group. Thus the master node 124 in group 12 knows the status of group links 1001 from node 121, group link 1002 from node 122, and group/network link 1201 from node 123, as well as the status of all the internal nodes and links within group 12. Node 124 can therefore calculate the available capacity across the group 12 between any pair of the links 1201, 1001, 1002. Preferably the master node 124 would use the "all practical paths" algorithm of our Australian Patent application 44470/99 (Docket No. 127045 SY) to calculate the trans-group capacity. This group information is
20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995

The units of the level B group domain are again grouped together, in this embodiment, into 3 network groups. The network groups include two one member groups 201 and 301, and one three member group 124, 113, 104. The network master of each one member group is the member of the group, while 113 is designated as the master of the three member network group.

The three network masters from level B interchange network information at the level C network domain. The information relates to the network links connecting the respective networks, and the trans-network information relating to the capacity between the pairs of network links.

- 5 At the regional domain, level D, the network masters 201, 113, 301 have been formed into two groups, resulting in two regional masters 201, 301, which exchange information on the available capacity between the two regions.

10 The regional master nodes 201, 301, convey the regional link capacity information to the other regional nodes. In the present embodiment 301 conveys the information to 113. 201 is the only regional node in the other regional grouping.

The regional nodes 201, 113 and 301 are all network master nodes and they convey the inter-regional and inter-network capacity information to the network level nodes. In our embodiments, 113 conveys this information to the nodes 104, 124.

- 15 Each of the network level nodes 201, 124, 113, 104, 301 is a group master and relays the higher level information to each of the nodes in its group.

The grouping of the units at each level means that the information exchanged at each level becomes more generalised.

- 20 This means that a node has detailed capacity information about the other nodes in its group. Capacity information about other groups in its network, capacity information about the other networks in its region, and information about the inter-regional capacity.

- 25 In a preferred embodiment the group master handles the interchange of node link capacity information. Each node, instead of broadcasting its load status to all the other nodes in the group, sends the information only to the group master, which collates the information from each node and relays the information to the other nodes. The message from the group master preferably incorporates the higher level load status information, so that each node has an overall picture of the entire system.

- 30 Thus the group master may broadcast a message including the information shown in Figure 3. The first segment RL includes the load status at the regional link level D. A second portion of the payload includes a number of segments of

5

The claims defining the invention are as follows:

1. A network arrangement for a plurality of nodes each node being connected to one or more other nodes by corresponding node links,

5 - the network being arranged into a recursive hierarchy of units having two or more levels,

- the nodes being the units of the first level of the hierarchy,

- the units of higher levels of the hierarchy being formed by groupings of the units of the previous level,

10 - wherein the units of a level exchange a corresponding load status information.

2. An arrangement as claimed in claim 1 wherein, within, each group of units, a master entity is designated, the master entity conveying inter-unit load status information relating to the units of that level to the next higher level.

15 3. An arrangement as claimed claim 1 or claim 2 wherein, in the first level, a selected node in each group is designated as the master node for the corresponding group,

- the master node managing the transfer of node load status information within its corresponding group.

20 4. An arrangement as claimed in claim 1 or claim 2, or claim 3 wherein the load status information includes information on the available traffic capacity between the ports of each unit.

5. An arrangement as claimed in any one of claims 1 to 4 wherein each node includes node load status monitoring means to monitor the load status of the links connected to the node.

25 6. An arrangement as claimed in any one of claims 1 to 5 wherein at least one node of each second level group is connected to a node of at least one other second level group via a corresponding group link whereby group load status information can be interchange.

30 7. An arrangement as claimed in claim 6 wherein the units of the third level are formed by mutually interconnected second level units.

- 5

DATED THIS TWENTY FIRST DAY OF AUGUST 2000
ALCATEL

ABSTRACT

To avoid the need for all the nodes of a network to know the load status of all other nodes and links in the network, the nodes 101.... 303 are organized in node groups 10, 11, 12, 20, 30. Each group has a master node, 104, 124, 113, 201, 301 which is incorporated in a logical higher order group. By recursively grouping the units of each preceding group, a logical hierarchical structure is formed in which the number of units at each level A, B, C, D, decreases.

Each node informs the other nodes of its load status, and each higher level unit also exchanges information with the other units. The recursive, hierarchical structure greatly reduces the amount of load status information exchanged across the network.

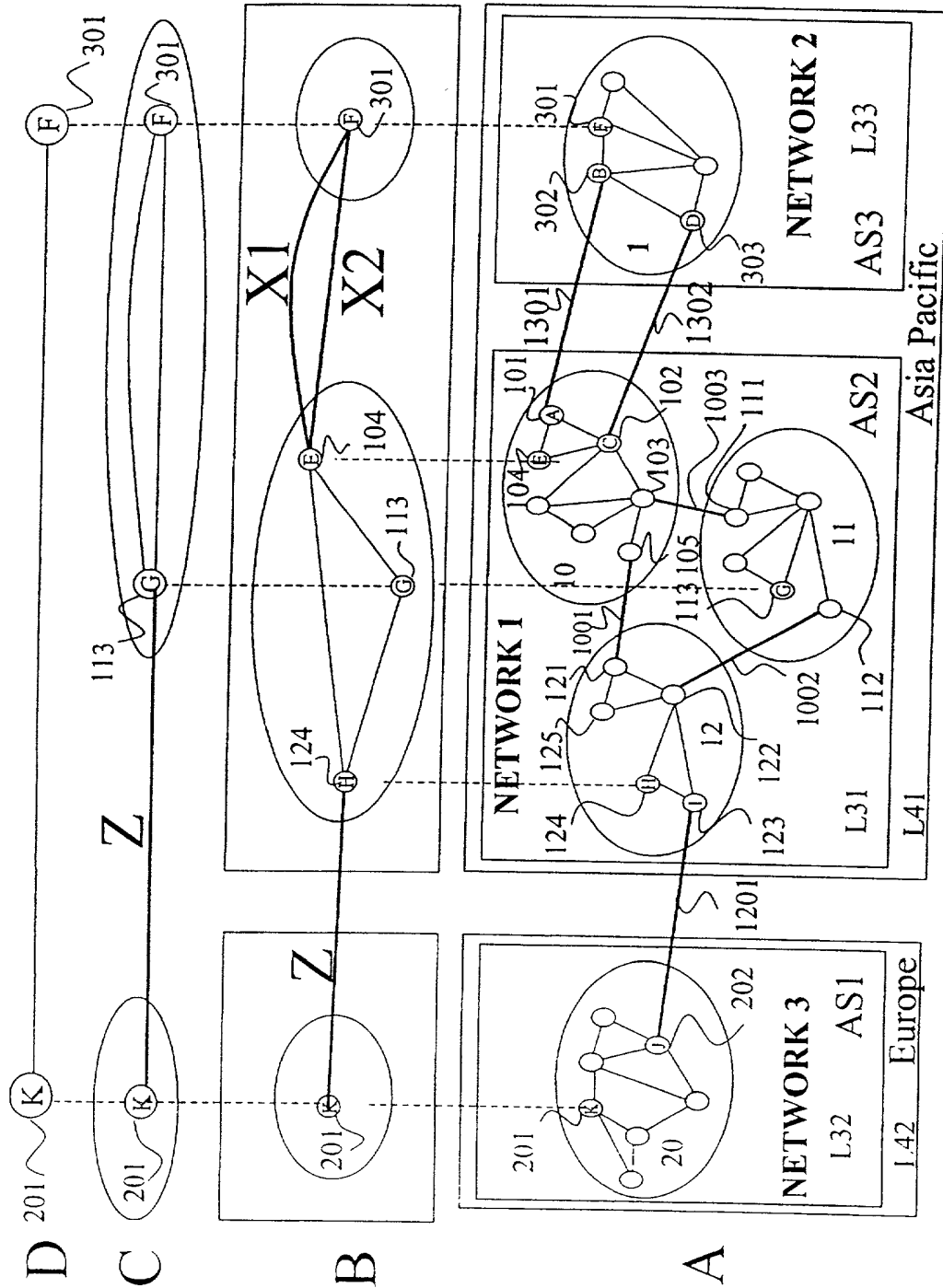


FIGURE 1

2/3

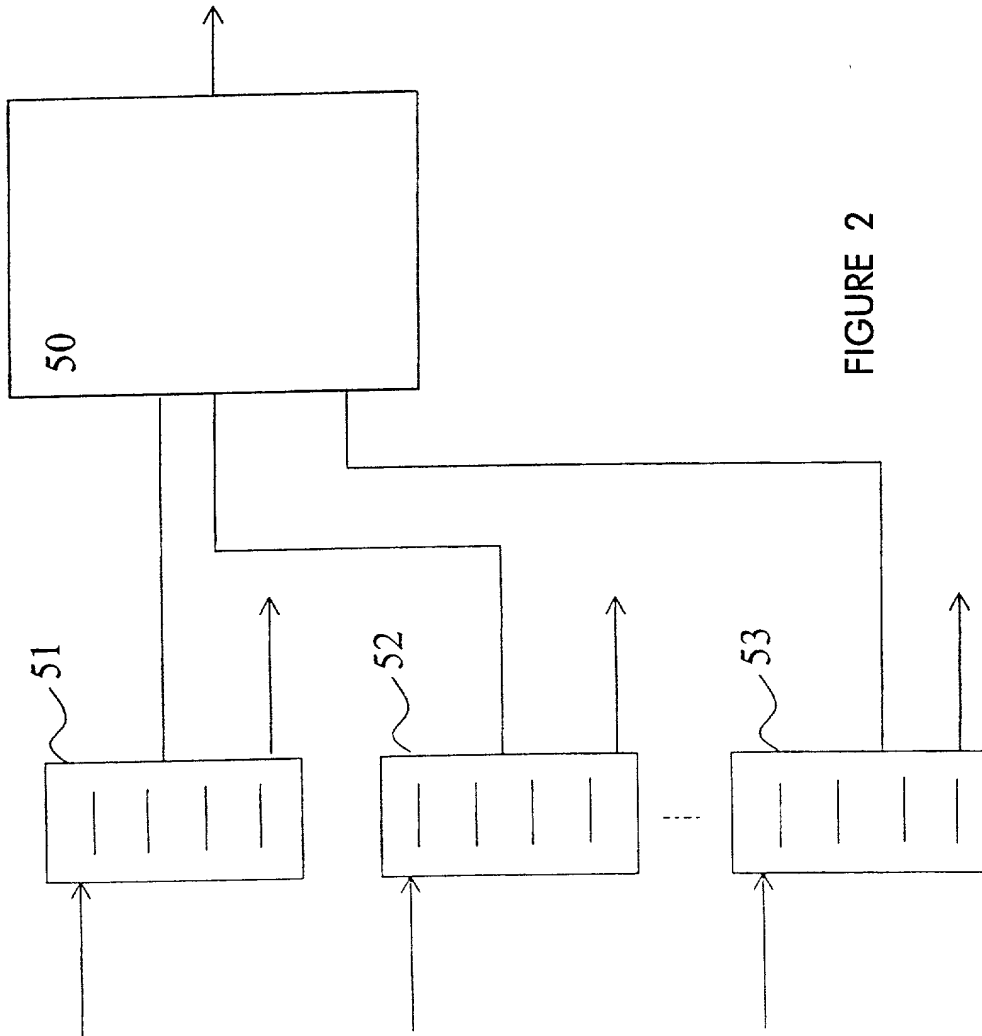


FIGURE 2

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FIGURE 3

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name: that I verily believe I am an original, first and joint inventor, together with the other inventors listed below, of the subject matter claimed and for which a patent is sought in the application entitled:

RECURSIVE TRAFFIC DISTRIBUTION IP/DATA NETWORK MODEL

which application is:

☐ the attached application
(for original application)

☐ Application Serial No:
filed

, and amended on

(for declaration not accompanying application)

that I have reviewed and understand the contents of the specification of the above-identified application, including the claims, as amended by any amendment referred to above; that I acknowledge my duty to disclose information of which I am aware which is material to the patentability of this application under 37 C.F.R. 1.56, that I hereby claim priority benefits under Title 35, United States Code §119, §172 or §365 of any provisional application or foreign application(s) for patent or inventor's certificate listed below and have also identified on said list any foreign application for patent or inventor's certificate on this invention having a filing date before that of any foreign application on which priority is claimed:

Application Number
47400/99

Country
Australia

Filing Date
September 6, 1999

Priority Claimed
Yes

I hereby claim the benefit of Title 35, United States Code §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in a listed prior United States application in the manner provided by the first paragraph of Title 35, United States Code, § 112, I acknowledge my duty to disclose any information material to the patentability of this application under 37 C.F.R. 156 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Application Serial No.

Filing Date

Status

I hereby appoint John H. Mion, Reg. No. 18,879; Thomas J. Macpeak, Reg. No. 19,292; Robert J. Seas, Jr., Reg. No. 21,092; Darryl Mexic, Reg. No. 23,063; Robert V. Sloan, Reg. No. 22,775; Peter D. Olexy, Reg. No. 24,513; J. Frank Osha, Reg. No. 24,625; Waddell A. Biggart, Reg. No. 24,861; Louis Gubinsky, Reg. No. 24,835; Neil B. Siegel, Reg. No. 25,200; David J. Cushing, Reg. No. 28,703; John R. Inge, Reg. No. 26,916; Joseph J. Ruch, Jr., Reg. No. 26,577; Sheldon I. Landsman, Reg. No. 25,430; Richard C. Turner, Reg. No. 29,710; Howard L. Bernstein, Reg. No. 25,665; Alan J. Kasper, Reg. No. 25,426; Kenneth J. Burchfiel, Reg. No. 31,333; Gordon Kit, Reg. No. 30,764; Susan J. Mack, Reg. No. 30,951; Frank L. Bernstein, Reg. No. 31,484; Mark Boland, Reg. No. 32,197; William H. Mandir, Reg. No. 32,156; Brian W. Hannon, Reg. No. 32,778; Abraham J. Rosner, Reg. No. 33,276; Bruce E. Kramer, Reg. No. 33,725; Paul F. Neils, Reg. No. 33,102; Brett S. Sylvester, Reg. No. 32,765; and Robert M. Masters, Reg. No. 35,603, my attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and request that all correspondence about the application be addressed to **SUGHRUE, MION, ZINN, MACPEAK & SEAS, PLLC**, 2100 Pennsylvania Avenue, N.W., Washington, D.C. 20037-3213.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date 28/8/00 First Inventor Michael S COX
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